The Principles of Mechanotherapy with Special Reference to the Treatment of Orthopedic Cases

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THE PRINCIPLES OF MECHANOTHERAPY WITH SPECIAL REFERENCE TO THE TREATMENT OF ORTHOPEDIC CASES.

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WHILE most other specialties in medicine are limited to the organ or organs with which they are concerned, orthopedic surgery in recent years has extended beyond the boundaries indicated by the name. Formerly an art limited to the treatment of real deformities, it has now been scientifically developed to that science which deals with certain pathological conditions of the static and motor structures of the body. In a narrower sense we may say that the treatment of deformities and the loss of function of these structures is orthopedic work, but since prophylaxis is the most important and perhaps that part of medical work which in the future will be most appreciated, the orthopedic surgeon should be at least consulted in all those diseases which threaten to produce deformities or loss of function of these structures, whether or not such diseases are usually treated by the medical man, the neurologist or the general surgeon.

The marked development of many ingenious operative and technical methods has sometimes overshadowed the value of the medico-mechanical treatment in orthopedic cases. This is certainly not right, for mechanotherapy is not only a very important auxiliary factor in the treatment and

prophylaxis of the diseases of the above-mentioned structures, but its place as a main factor in many conditions should always be appreciated.

From this point of view let us consider briefly the value of mechanotherapy: (1), in prophylaxis; (2), as a preparatory treatment; (3), as the main treatment; (4), as an after-treatment.

In the first place, the technic itself and the persons who can help the orthopedic surgeon to accomplish his task must be considered.

In using the term "mechanotherapy," reference is made to all varieties of therapeutic methods which are applied in strengthening and improving the function of the motor and static structures, exclusive of those which require the use of an anesthetic to avoid pain and spasm. These methods are active and passive movements, massage and hyperemia.

An active movement has its origin in the motor centers of the brain, which stimulate the muscles by means of the nerve tracts. The muscles move the bones at the joints. In employing active exercises use is made of the general principle that anything affecting one part of the system affects sympathetically all other parts to a certain extent. A patient with a Colles' fracture will need many exercises before he is able to write again as well as before the injury, not only because his joints are stiff and his muscles weak, but also because his motor centers need retraining. On the same principles the modern therapy of tabes and other nervous diseases has been developed by Leyden, Goldscheider, Fraenkel and others.

For the muscles themselves active exercises have a special importance, because the production of motion is a function of the muscles, and in no other structure is the effect of the performance of its function so distinctly apparent as in the muscle.

The experience of daily life shows this effect as an increase of power, energy and volume. For example, we see the muscle hypertrophy under work in the arms of athletes and blacksmiths, in the legs of dancers and mountain climbers. Furthermore, the exact experiments of Treves, Mosso and others [1] prove the direct influence of exercises on the development of muscular endurance. These effects, namely, increase in size and development of endurance, are the results of the temporary changes which take place in muscles during the period of active exercises. We see in the muscle as in other organs during the time of the function an increase of the circulation and of the metabolism. The performance of function depends upon certain stimuli which regulate the conveyance of the nutrition to the given organ. This consideration shows the great difference between active and passive movements. In the former we have the advantage of the physiological stimuli, which are not present to such an extent in passive movements and massage.

The direct effect of active motions, the improvement of circulation and metabolism in the muscles, will be of advantage also to the joints and bones which are moved by them. In daily life a few motions are sufficient to restore the function of the limbs which have become somewhat stiffened by the night's rest. Under pathological conditions regular systematic training is needed to obtain the same result. As it is evident that voluntary or involuntary misuse of muscles injures the functions of the joints, it follows that proper use of the muscles is the logical method to employ for their correction.

Furthermore, not only the function of the joints is influenced by use or misuse, but even the structure of the bones. This is well expressed by

Wolff's law: "Every change in the formation and function of the bones, or of their function alone, is followed by certain different changes in their internal architecture and equally definite secondary alterations of their external conformation in accordance with mathematical laws."

In a previous paper [6] I have mentioned the influence of exercise upon the general circulation and development of the whole body. This is important also in orthopedic patients, especially those affected with paralysis, whose general health often suffers from lack of sufficient exercise.

In many cases the use of active movements must be limited, as, for example, where there exists stiffness in joints, or paralysis. Then passive movements must be given to limber the joints or at times to obtain any motion at all. But even in these cases, from the very beginning active exercises should not be neglected. While the physician makes passive movements the patient at the same time should make active movements in the same direction, or in completely stiffened joints he should make rhythmical active contractions of the muscles. In this way a double effect is obtained. The combination of active and passive movements must not be arbitrary, but must be adapted to special purposes and so must be different for different joints, and the more complicated the mechanism of the joint, the more complicated is the relation between the active and passive movements. In accordance with the above, resistance movements have a very important rôle to play, especially when the weight of the extremity pulls down. For example, in treating an injury to the shoulder-joint, when the deltoid muscle is too weak to raise the arm alone, we aid the active by passive motions, and when the joint is somewhat stiff, by the application of

additional force the arm may even be raised beyond the limitations imposed by the stiffness. On the other hand, since the weight of the arm naturally would bring it down without necessitating any work on the part of the antagnostic muscles, we can, by slightly resisting the downward motions of the arm, make active motions of the antagonistic muscles necessary in order to bring it to its normal position at the side of the body. It may be added that resistive movements are to be used not only in such specific cases as the above, but in general whenever we wish to increase the strength of the muscles and the natural resistance is not sufficient for this purpose.

Massage is used in orthopedics in all forms. We find good prescriptions for these different forms in the textbooks of Mitchell, Graham and Hoffa. These authors give the technic in a very clear way and avoid the mistakes of others who fill their books with an enumeration and description of an enormous number of various manipulations. On the whole, massage in orthopedics is not complicated, but the selection of the right forms for the right cases needs usually a careful study and some experience. Certainly we can injure our patients by wrong use of massage as much as we can aid them by the right methods.

Both massage and manipulations may be performed also by apparatus, although the special value of such apparatus as Zander's or Krukenberg's, designed for this purpose, is not so great in orthopedic conditions as in some internal diseases. Exceptions will be mentioned later. Nevertheless, it is a great advantage in treating a large number to cases to have at one's disposal various machines which can be regulated in an exact way. The Zander machines, especially, enable us to give the various forms of massage,

such as vibration and tapotement, in such an energetic and persistent way as is not possible for the hand.

Bier's active and passive hyperemia produced by hot air and congestion are very valuable auxiliary methods which are used in combination with the others mentioned above.

Bier and others recommend the use of suction apparatus in stiff joints. We have had no experience personally, but this method requires somewhat complicated apparatus and, as a rule, we should try to make our methods as simple as possible. For this reason Bier's congestive hyperemia by rubber bandages may be recommended. In stiff joints of long standing we have not seen such remarkable success as is reported by Bier himself, but in cases of acute and subacute arthritis the influence of congestion is often so good that general use should be made of this method, at least in hospitals, where day and night supervision is possible.

These treatments always require considerable time, and in many cases for months, even for years, treatment must be continued. Therefore, not only the amount of time required, but also the financial circumstances of the patients, will make it impossible for medico-mechanical methods to be applied by the physician himself. He needs assistants, who must be carefully trained to carry out his orders. I quote Mitchell,[10] who says: "It is necessary to impress on the manipulator that he has duties and obligations to the physician, whose hands, so to speak, he is for the time, as well as to the patient. In all cases direct orders should be asked from the attending physician and the most precise loyalty be observed in carrying out instructions in letter and spirit. Anything observed by the operator which might be of use

in the care of the patient should be reported to the physician at once and his advice taken in any difficulty or doubt."

In many cases the physician needs the help of the parents or other people who have no special training, especially in those cases which require treatment for years, as, for instance, in lateral curvature. The amount of improvement in many of these cases will depend upon the intelligence and energy of such assistants. As far as possible, the physician should supervise the treatment, that he may change the prescriptions. A special advantage of medico-mechanical or gymnastic institutes is that certain exercises may be studied, alone or in classes, by the patients and also by those who help them, under expert direction.

In a certain number of cases, however, the physician should not intrust the treatment to laymen, as, for instance, fractures before bony union is entirely complete, or joint lesions while any acute symptoms still persist. Hoffa says, in his textbook of massage, "Massage and manipulations must be done by the doctor himself and only exceptionally by laymen." In practice it will hardly be possible to fill this prescription, but it shows how highly such a competent man valued these often undervalued methods. Training in massage and mechanotherapy should be a part of orthopedic training, just as the plaster of Paris technic or any other mechanical work.

I. PROPHYLAXIS.

The following is given as an example of the value of mechanotherapy as a prophylactic measure. In poliomyelitis many neurons are injured. It is impossible to determine how many will regain their function, but one can aid this process by giving adequate stimulation with massage and

exercises. It is not sufficient to tell the parents to rub their children, but each case must be studied to know which will be the best method. Even active motions may be used, as recommended by Bradford and Lovett:[2] "Active muscular exercise of the paralyzed limb is a most desirable tonic to the affected muscles, however it is obtained, provided the muscles be not overtaxed. With the assistance of the parent's hand, a foot which naturally drops forward from paralysis of the anterior leg muscles can be flexed, and with each repetition of the exercise the muscle may be found able to accomplish more. It is impossible to lay down any series of exercises. In each case the problem must be met differently. The aim should be so to assist the affected muscles that if they have any power left they may be enabled to use it daily for their own advantage. And with this in view, assistance should be rendered by supporting and aiding the affected limb in its movements in the way most likely to call into use these paralyzed muscles. Such exercises form a most useful adjunct to the massage. It should be repeated each night before or just after the massage."

On the other hand, one must try to prevent deformities liable to follow by reason of the loss of normal antagonism. Casts are often necessary, but mechanotherapy must be used with or without casts for the improvement of nutrition and circulation of the more or less paralyzed muscles, as well as to aid in preventing contractures. From a functional point of view one should say that it is a mistake to give here as in most other conditions, for instance, lateral curvature, braces alone. Each fixation weakens the fixed extremities, and this disadvantage must be avoided by exercise at the same time.

Such careful treatment will prepare the patients for operations, which may then be done more easily when it is seen that nothing more can be gained by conservative methods.

The same is true in cerebral paralysis and hemiplegia. Especially in the latter condition careful exercises are perhaps the best way to prevent further attacks of apoplexy by increasing the tone of the blood vessels.[8] In such cases Zander institutes are of a special value because they enable us to vary and enrich our manipulations, and this is necessary in a treatment which always needs a long time.

In many joint lesions careful treatment by active and passive motions, as early as the acute symptoms will allow, prevents loss of function. The resorption of blood or fibrin may be hastened by massage and active motions, and this is also the best way in which to avoid contractures of the muscles. These methods may be used in connection with splints, plaster Paris, drugs or vaccines. One of the great advantages of the traction method, invented by Gurdon Buck and Crosby, and developed to a high and elaborate technic by Bardenheuer,[3] in the treatment of fractures and dislocations, is that the dressing allows motions of the injured extremities to be made before union is obtained. Bardenheuer begins very early with such motions; for instance, in fractures of the wrist on the fourth day, of the elbow on the tenth or twelfth day, in impacted fractures of the humerus on the second or fourth day, in unimpacted fractures of the humerus after one or two weeks.

The best and perhaps most important part of our whole therapy in lateral curvature is prophylaxis; we must often be satisfied when we are able to prevent increase of the curvature. Zander

says modestly:[7] "We are usually not able to straighten out cases of progressive curvatures, but we try to cause them to grow straight."

II. PREPARATORY TREATMENT.

Secondly, mechanotherapy is to be considered as a preparatory method for forcible manipulations and operations. For instance, in septic joints, in many cases all the tissues are involved, the capsule is thickened, the cartilage more or less destroyed, there are adhesions in the joints, the tissues around the capsule are thickened and fixed to it and there are similar processes in the tendon sheaths. Often there are scars directly over the affected joints firmly fixed to the tendon sheaths and the capsule. If we try to mobilize such joints forcibly, we will tear some of the adhesions and perhaps get some motions during and shortly after the anesthesia, but often this success is only brief. In tearing such adhesions we produce hemorrhages into the joints and between the soft tissues, which will produce new adhesions and increase the amount of material which has to be absorbed.

The better way in such cases is to loosen systematically the adhesions by careful passive movements, to loosen the various tissues from each other by massage and to strengthen the muscles by massage and active motions, which will also help to stretch adhesions. It will soon be evident how much we may gain by these manipulations, and after a short time we may more effectually and easily use ether to further mobilize joints and tendons which are in better condition than they would have been without a course of preparation. Often it will not be necessary to use ether provided the case makes satisfactory progress.

We have personally sometimes had occasion to

treat cases which have been treated previously with forcible manipulations under ether and were sent for after-treatment to the medico-mechanical department. We were not able to find that the manipulations had had any beneficial effect and the patients still complained of a great deal of pain, much more than before the forcible manipulation. I have often felt that in such cases we would have done our work better and *more quickly* by using *slower* methods. The temptation is always very great to help our patients in the shortest possible time, but we should never forget that *we* do not heal the patients, but are only able to help nature in accomplishing her work. And to attain this end our first duty is always to do no harm.

III. AS THE MAIN TREATMENT.

In practice we cannot separate those cases which we wish to treat mainly by mechanotherapy from those which have only to be prepared for other treatments. Routine treatment must be avoided. In each case and in each stage of each case we must decide which method is the best. But there are several orthopedic diseases which need mechanotherapy as the main treatment.

Lateral curvature is perhaps the most difficult and subtle chapter of orthopedic work. There have been many discussions as to the best treatment, but no agreement has yet been reached. Exclusive and careless use of mechanotherapy in all cases has brought these methods into disrepute and has driven many patients to laymen who claimed to be able to cure lateral curvature by simple exercises. The mechanism of the spine, however, and especially of the curved spine, is so extremely complicated that it is impossible to

control lateral curvatures by simple symmetrical and even asymmetrical exercises. However, from a theoretical and practical point of view, functional medico-mechanical treatment should always be the main part of our treatment, whether or not we combine these methods with forcible manipulations and fixed braces. We need, moreover, special apparatus. Zander has the honor of having introduced such apparatus, and his statistics, published by Nebel [7] in 1889, show the remarkable results which he obtained with his own apparatus. Progress in the knowledge of the pathological conditions has made possible the development of special apparatus to a still higher degree, as, for instance, Schulthess' [4] ingeniously constructed machines. But we think Lange [5] is quite right in demanding methods which are as simple as possible, so that the poor also can more readily be treated. With this principle in mind, Lange has constructed his apparatus for active and passive over-correction so simply that it can be used even in schools, as he has already done for ten years, and with the best results.

The space here does not allow us to consider in detail the best way to combine supporting and exercise treatment. The textbooks of orthopedic surgery, especially those of Bradford and Lovett, Hoffa, Joachimsthal (article of Schulthess), furnish sufficient details. But we wish to emphasize the fact that in all forms of lateral curvature functional treatment by exercise shall be considered as essential.

In reporting results, necessary care and criticism has not always been used. Lange condemns the methods of showing results by simple photographs and shows pictures which prove how easily we may deceive ourselves about the real work we have done when we print photographs, especially

those made shortly after the wearing of a plaster of Paris cast. The only scientific way, according to Lange, Schulthess, Zander and other excellent authors, is to make exact measurements. To accomplish this purpose Lange has built a very simple apparatus of more general use than Schulthess' and Zander's measuring apparatus, and which has the great advantage over them in that we may make the measurements in several positions in order to show how much movement we have gained by our treatment in fixed lateral curvature.

In simple cases of faulty attitude, exercises are by far the most effectual treatment. Goldthwait found that faulty attitude is a very widely spread affection among both old and young people. There is no doubt that lack of muscular energy is the main causative factor and any ordinary form of sport, as mountain climbing, rowing or working in a gymnasium, will be found to be the most effective method of preventing wrong attitude with all its following troubles, such as strain of the sacro-iliac joint, the knees and feet. This, however, is more a problem for schools and clubs. It is a question whether we should employ exercises with or without massage in cases where strain is present. Often in slight cases exercises are sufficient to cure entirely the trouble, while the more severe cases will need a combination of strapping or braces with mobilization. In slight cases a careful selection of exercises is not necessary, but in difficult cases we must be careful to strengthen those muscles alone which are relatively weaker than their antagonists. For this reason common exercises at home are usually ineffective; the conditions are like those in lateral curvature, in that we need apparatus which permits exercising only certain groups of muscles and only to a cer-

tain extent. Zander's apparatus is very good in such cases, because it allows us to place the patient in a comfortable position to work with certain muscles only, while the others are resting so far as seems best. At all events, when it seems best to prescribe a brace, we should never neglect prescribing exercises also. A complete cure can hardly be obtained with fixation only. When such cases have a severe strain with spasm of the muscles, massage is to be administered in a very careful way. It is not absolutely wrong to give such muscles massage, but we must employ a very gentle massage which gives only a slight stimulation to the skin, while to the antagonistic muscles we give a vigorous and strengthening massage. In cases of long standing, however, with adhesions between the muscles and the surrounding tissues, we must try to break these adhesions first by kneading and passive manipulations. For this purpose anesthesia is sometimes required, but we should give first one or two weeks of treatment by massage alone.

We have mentioned the necessity of preventing loss of function in lesions of joints and have considered mechanotherapy a very important factor in connection with this problem. Very often, however, we are not able to accomplish what we wish; stiffness or deformities will result, and the whole extremity will be more or less affected. Then the value of mechanotherapy is still greater in getting good end-results, although we often need, as we have said above, forcible manipulations, braces and operations as adjuncts.

In stiffness of joints following injuries we need energetic passive motions with massage in order to loosen and stretch the capsule and ligaments. The muscles at the same time must be strength-

ened by massage and active motions, and if such motions are prevented by stiffness, we induce the patient to make rhythmical contractions of the muscles.

The amount of energy that we may use in joints stiffened by infectious processes depends upon the degree of inflammation. When we have reason to think that inflammation is still present, only careful active and slight passive motions may be used, and preferably after baking. No apparatus should be employed. However, in joints which have been stiffened for a long time, and the inflammation has subsided, all methods must be applied with great energy. Prognosis is, of course, very doubtful, but with much patience and energy great improvement may be obtained even in joints which have been stiffened for years.

In atrophic or rheumatoid arthritis, general tonic treatment is of the greatest importance, but we need massage and slight motions for the restoration of the functions of the joints. This function, however, can be only partly obtained. It is very doubtful how much influence we exert on the disease itself by medico-mechanical treatment.

In hypertrophic arthritis we must avoid all stimulations, but after the process is ended we may at times employ mechanotherapy to advantage. The following paragraph from Bradford and Lovett [2] seems to us appropriate:

" It is particularly important that all means of elimination of waste products should be encouraged. It is for this reason necessary not only that the intestines should be normally active, but it is also desirable that both the perspiration and kidneys should have an opportunity for free action. As the latter are influenced by increase of fluid in the patient's diet, it is to be carefully

prescribed. Exercise promoting a free perspiration is also desirable. This in weaker patients can be done by the judicious use of hot baths and hydrotherapeutics, but where exercise is possible, perspiration which results from muscular effort is more beneficial."

IV. AFTER-TREATMENT.

In using the term " after-treatment," we refer to those orthopedic diseases which need a special form of treatment in the main, but a medico-mechanical after-treatment in order to improve the function of the affected part. After good reduction of a congenital dislocation of the hip, the use of the limb in daily life will often be enough to restore its function, although we sometimes have trouble in bringing back the leg to the right position. Then passive motions with massage will accelerate the process. After the reduction of a clubfoot, walking is the best method to keep the foot in its new position, but in some difficult cases it is necessary to use a brace for a long time, and during this time exercises should also be employed.

The same is true for the treatment of wry-neck. In this condition the danger of recurrence is always very great, so that Mikulicz even resected the sterno-cleido-mastoid. Usually the tenotomy, or the lengthening of the tendon, is sufficient, but obtaining a good end-result requires a brace in many cases; and while wearing this exercises should not be neglected. Furthermore, exercises are considered a strong factor in altering the shape of the bones of the neck and the head which often in these cases show such remarkable deformities.

In spasmodic torticollis several authors recommend massage and exercises; personally we have

not seen good results even in slight cases, although the time spent by the patients in the treatment was perhaps too short. Sometimes the patient felt some subjective relief. We consider the operative method the only way to cure this often very disagreeable and serious trouble, but after the operation an active training of the muscles and nerves of the neck will be of great advantage in accomplishing the desired result.

Our work in flat foot is only half done when we have relieved the pain with supports. We should try, especially in young patients, to complete the cure by regaining the normal antagonism of the muscles of the calf, so that we restore the foot and make it independent of any support. Such treatment needs a good deal of persistence on the part of the patient, and we often will obtain better results by giving him a simple apparatus, such as that invented by Osgood.[9]

Mechanotherapy ought not to be used in tubercular joints. Even after the infectious tubercular process is ended, exercises for the relief of stiffness are not advisable. Massage may be given with great care to the atrophic muscles, but the joint must not be manipulated. Concerning the recommendation of hyperemia in tubercular joints, we refer to Bier's monograph.

It is impossible in a paper such as this to enumerate all the orthopedic conditions which may be treated by medico-mechanical methods; these examples given show briefly the methods and indications.

It may be added in conclusion:

1. Mechanotherapy must be considered as an essential factor in the treatment of many orthopedic conditions.

2. The result obtained from it will depend in a great measure on the correct use of the methods

and the experience of the surgeon and his assistants.

3. The treatment must be elaborated for each single case according to the anatomical, physiological and pathological conditions.

4. The most important instrument in mechanotherapy used in orthopedics is the hand of the surgeon, but for several conditions apparatus is required for treatment. For a hospital with a large out-patient department, it is a pre-eminent advantage to have at its disposal a medico-mechanical department fitted with apparatus such as Zander's, where the treatment, singly or in classes, and under expert direction, may be carried on in a varied way.

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